TOWN OF CALAIS

TOWN HIGHWAY No. 6, CENTER ROAD

INFORMATIONAL REPORT re: the
EXISTING 5' DIAMETER CORRUGATED CULVERT
NEAR JUNCTION WITH TH 57, ADAMANT ROAD

PREPARED BY NEWTON TECHNICAL SERVICES
JULY 2014

Introduction:

This report is intended to provide some background information relative to the size and condition of the existing structure on Center Road as well as provide some recommendations for upgrading and improving the effectiveness of the structure if the town so desires.

Location:

The existing structure is located on TH 6, Center Road approximately 100’ from the intersection with TH 57, Adamant Road. Standing on Center Road and looking northeasterly towards the intersection and the Adamant Co-op, the brook flows from left to right; that brook is a direct result of the overflow from the pond located just northerly of the intersection.

Existing Structure:

The existing structure is an old 5’ diameter, 32’ long corrugated metal culvert which appears to have been in place for a long time; that existing culvert provides approximately 19.6 square feet of waterway area. The invert appears to be fully intact with no deterioration visible.

Behind the brush and overgrowth, there are remnants of laid-up stone headers on each end of the culvert; there doesn’t appear to be any wingwalls on either end.

The stream on the inlet end of the culvert is not aligned well with the inlet end of the culvert and makes several sharp turns before getting into the pipe. The brook on the outlet end is in a much straighter line than the inlet, but it is positioned very close to the house and concrete retaining wall that sets between the house and the brook.

Looking upstream along concrete retaining wall towards outlet

Hydraulic Requirements: According to the preliminary hydraulics report done by the Vermont Agency of Transportation in May 2010, the drainage area for this crossing is 2.4 square miles or nearly 1540 acres; some of that drainage area consists of several large ponds and some wetland areas. A copy of that report is attached.

The analysis shows that the existing structure is significantly undersized when compared to what is currently required for a new structure on a town highway. That analysis is based on what is referred to as a Q25, which is defined as the worst storm you could theoretically get in a 25-year period; the structure at the site should be able to handle the rainfall from such a storm and still have 1' of freeboard in the structure.

As noted above, the existing structure provides almost 20 square feet of waterway area; the hydraulics report suggests a structure with a minimum clear span of 10' and a minimum of 48 square feet of waterway area.

As it is now, because the existing structure is undersized, there's a very likely chance that water from a 25-year storm would overtop the roadway. A similar storm occurred in the spring of 2010 and the problem was compounded when a beaver dam in the pond just upstream of this site let go. Water levels rose to the point that the next structure upstream from this one was overtopped and water ran down the road damaging both public and private property.

Flooding and subsequent damage occurred in May 2010

Vermont Agency of Natural Resources Requirements: When working in the waters of the state, towns, designers, landowners and contractors work closely with ANR to make sure that any work that is done, and any new structures that are installed, meet the minimum requirements that ANR is looking for.

Each project requires a permit to do the work and meeting and working with ANR's local Stream Alteration Engineers early on in the process ensures that all involved are aware of the requirements and the language spelled out in the permit.

In the last few years, ANR in conjunction with the Fish & Wildlife Department has put a greater emphasis on specifying that the invert of any new structure is buried a minimum of 1' below the existing channel grade. Burying the structure's invert below streambed grade helps do 2 things: (1) it provides a natural bottom in the new structure making it easier for fish and other aquatic habitat to adapt to the new crossing and (2), in the case of large rainfall events it provides more stability for the structure and lessens the chance of it being undermined or washed out.

Earlier this spring, ANR revised their policy on burying the inverts of new structures deeper than the previous required minimum depth of one foot. However, ANR's Stream Alteration Engineer has visited this site and also checked with the Fish & Wildlife Department with regards to embedding the invert. As a result of the dam and the pond immediately upstream of this location, they would be satisfied if the invert of a new structure was buried 1' below the streambed to help promote in-stream spawning.

During their site visit, ANR has said that any new structure can be relocated to be further away from the house and retaining wall, and that the brook on both the inlet and outlet ends of the existing structure can be realigned.

Selecting a New Structure: When looking at options for a new structure, we took into account the following criteria: what size of structure would be needed to meet the hydraulic requirements, what type of structure would fit in and look the best at this site, and what would also fit the field conditions and still meet the recommendations and requirements set forth by the Stream Alterations Engineer.

Due to the limited height of cover over the structure, options for a replacement structure are limited to something with a longer/wider span and not too much of a vertical height or rise.

From strictly a hydraulics standpoint, one structure that would work is an aluminum plate pipe arch with an inside clear span of 10'-3" and a rise of 6'-9". It has a minimum clear span of 10', has an initial waterway area of 55 square feet, and when the invert is buried one foot below streambed, it still has 48.1 sf remaining and therefore meets the hydraulic requirements.

The headwalls and wingwalls could also be made from the same corrugated aluminum plate. They have anchor rods and deadmen attached to both the headwalls and the wingwalls to provide stability; the anchor rods from the headwalls are attached to the pipe arch itself and the ones attached to the wingwalls are connected to deadmen buried in the slope.

Constructed from high strength aluminum structural plate, this type of structure (both the pipe arch, and the wingwalls and headwalls), comes as a series of plates and are bolted together in the field. One of the nice features about this type of structure is that you don't need any specialized equipment such as a crane to set it in place; it's not so heavy but what a contractor can set it with a normal-sized excavator which is something that is generally already on the project.

One drawback of this option is that even though it would be buried one foot, the roadway grade thru the area would probably have to be raised a little in order to provide sufficient cover over the new structure.

An example of this type of structure with aluminum headwalls and wingwalls is shown below.

Aluminum Plate Pipe Arch with Aluminum Headwalls and Wingwalls

The estimated cost for a project using this type of structure is around $70,000 - $75,000.

A second option that would work is an aluminum box culvert that has a span of 14'-10" and a rise of 4'-10". It meets the minimum clear span of 10' and has an original waterway area of 63.2 square feet. When its invert is buried 1' to meet the ANR requirements, some waterway area is lost but it still has 48.4 square feet remaining, just slightly more than the 48 sf that is required.

As previously noted, this option is also constructed from high strength aluminum structural plate, and comes as a series of plates that are bolted together in the field.

If desired, the headwalls and wingwalls could also be made from the same corrugated aluminum plate as noted above, and they would also have the same combination of anchors and deadmen to ensure stability.

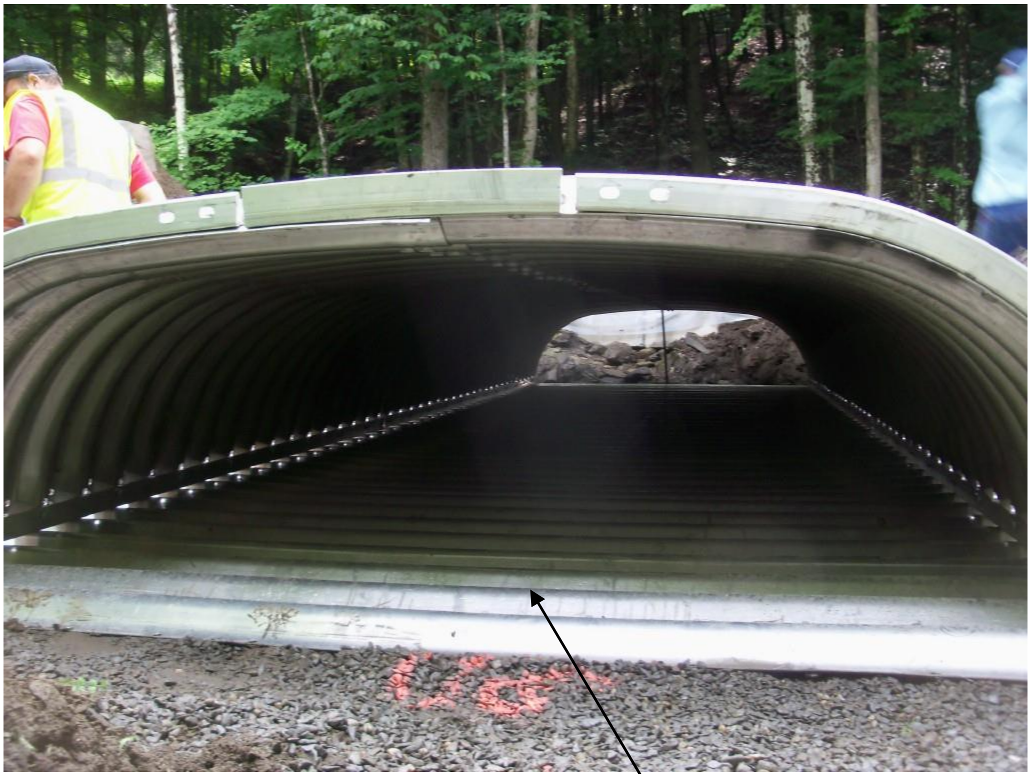
Although a different size, this option is similar to the new structure that the Calais road crew just installed on TH 39, Max Gray Road. The new aluminum box culvert has a span of 10'-2" and a rise of 2'-8" and was used to replace an existing 36" culvert that was not big enough to handle the water during periods of high flow.

The corrugated aluminum material for the box culvert and the wingwalls and headwalls was delivered to the town garage and the Calais' road crew assembled it; once they had the old pipe removed and the area prepped for the new box culvert, they brought the new structure to the site, set it in place, and began the backfilling and compaction work.

The project went well, came out nice and should serve the town well for years to come.

Pictures from that recent installation are shown below.

New Aluminum Box Culvert being installed on Max Gray Road



Aluminum Box Culvert set in place

The estimated cost for a project using this type of structure is around $70,000 - $75,000.

A third option would be to install a precast, reinforced concrete box; the inside dimensions of the box would need to be a minimum of 10’ wide x 6’ high. That would need to be buried 1’ as well, leaving an opening of 10’ x 5’ or 50 square feet of waterway area when complete. Concrete headwalls and wingwalls would be installed off each corner of the box to help transition the flow in and out of the structure.

A couple of drawbacks with this option are (1) due to the weight of the pieces involved, a crane would be required to unload and set a structure like this and (2) all of the material used to infill the box so it’s 1’ below streambed would have to be done after the box is set in place; in addition, due to the thickness of the roof slab, there wouldn’t be as much cover over the top of the structure so the roadway grade would have to be raised, and there is also a longer lead time to get this product.

The structure would be wide enough to use a skid-steer or something similar to move most of the streambed material in place, but it may also present a problem because of the relatively low height inside the box.

An example of a recent precast concrete box culvert project is shown below.

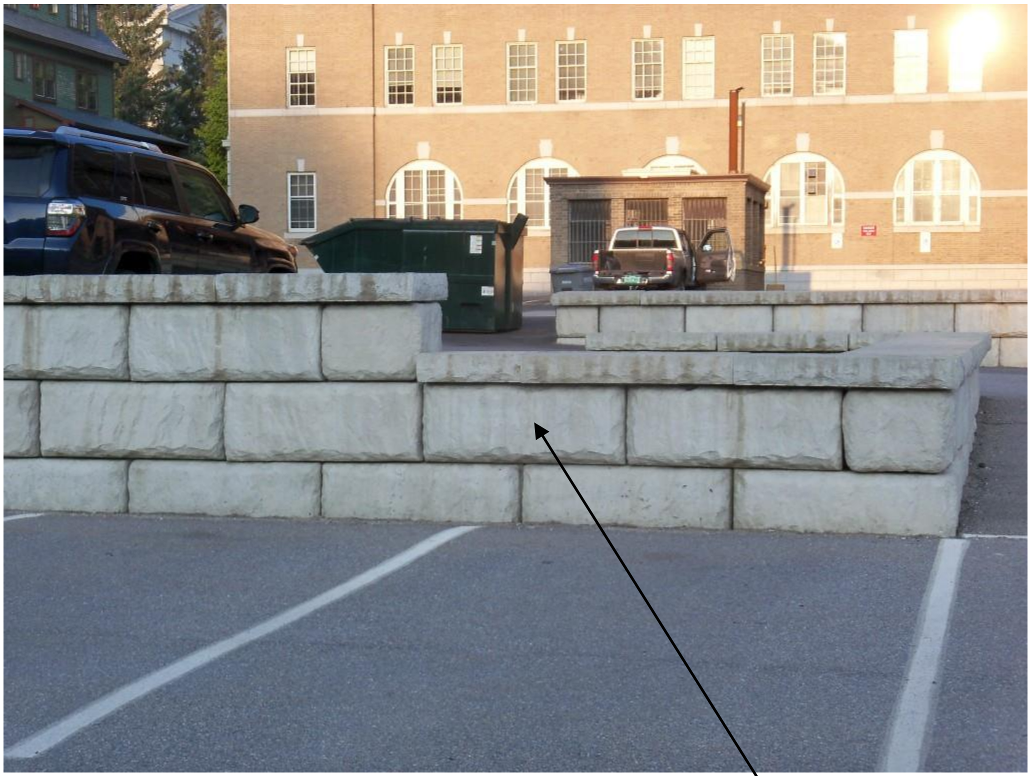
Precast Concrete Box Culvert with Precast Concrete Wingwalls

The estimated cost for a project utilizing a precast concrete box culvert would be in the range of $75,000 - $80,000.

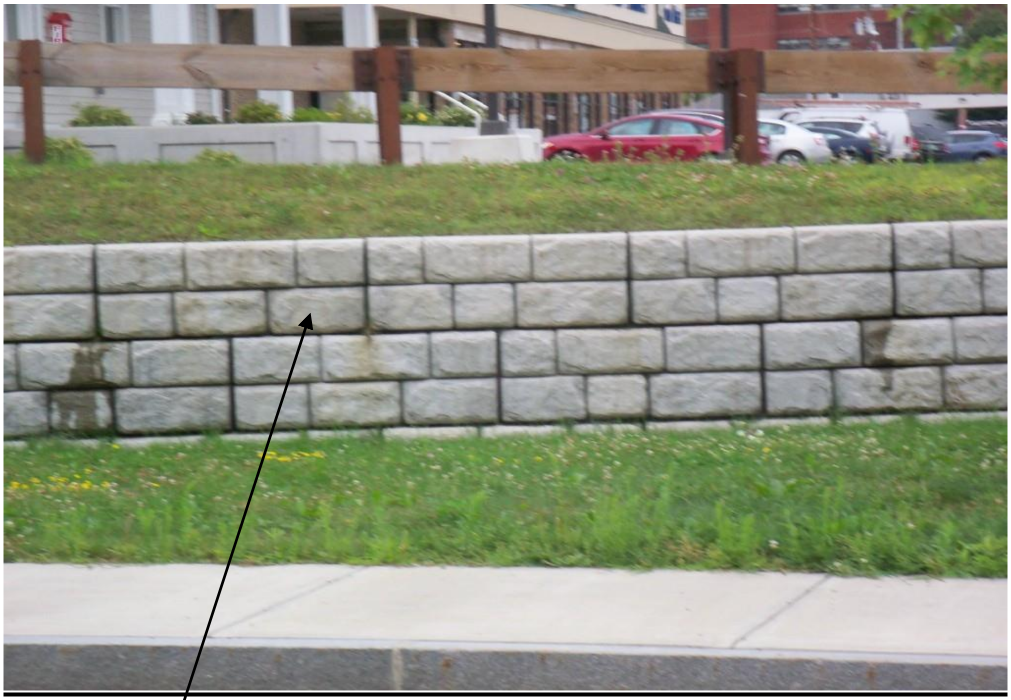
<u>Recommendations:</u> Of the options discussed, the installation of an aluminum box culvert seems to be the best solution to the problem. It meets all of the hydraulic-related criteria, it’s relatively lightweight but still maintains its structural integrity, it is cost-effective, and the roadway grade would not have to be adjusted to provide any additional cover.

Since this location is in an aesthetically pleasing and quite pristine area of town, portions of the headwalls and wingwalls could be constructed using an architectural form of concrete. To provide stability and to protect from scour, the bottom of any concrete substructure, i.e. headwall and/or wingwall needs to be 4’ below streambed elevation. However, the visible portion of the headwalls and wingwalls above streambed could still be constructed using precast concrete and still be an attractive addition to the area.

Redi-Rock blocks are a structurally sound, precast concrete product that “locks” together when placed on top of each other and could be used for the wingwalls. They come in 3 different patterns as shown below.



Redi-Rock Retaining Wall (Limestone Face)



Redi-Rock Retaining Wall (Cobblestone Face)

Redi-Rock Retaining Wall (Ledgestone Face)

Another option to consider when constructing the headwalls and wingwalls with concrete is the use of a formliner material. The formliner is placed in the concrete formwork prior to pouring the concrete; when the concrete is poured, it flows around the formliner material and then when the formwork is stripped, the finished surfaces that will remain exposed have a pattern to them.

A couple of examples of that type of work are shown below.

Cast-in-place Concrete using a "Cobblestone" Formliner

Cast-in-place Concrete using an “Ashlar Stone” Formliner

The estimated cost for using the Aluminum Box Culvert with a 14’-10” span and 4’-10” rise, and constructing the headwalls and wingwalls with an architectural-type of concrete whether precast and/or poured-in-place is $80,000 - $85,000.

Summary: The existing 5’ diameter culvert is in relatively good shape for having been in place for a long time. The problem however is that it is not large enough to meet today’s hydraulic requirements; during a large rainfall event, water would likely overtop Center Road leaving that road impassable again and requiring the town to repair any damage once the water recedes. In addition, local property owners would probably incur damage of their own that they would have to repair.

Because the existing culvert is still in good condition, if and when it’s replaced, it could be put back into the town’s inventory and reused in another location where the drainage area is smaller so it would be able to provide the necessary waterway area.

A new structure, selected from the options given, could be installed and immediately provide the required waterway area. The brook would be realigned on each end of the new crossing making everything more efficient; stone fill would be added to protect the ends of the wingwalls from scour and bank erosion.

There’s no question that improvements such as this come with some cost but the majority of funding for a project like this would come from the Vermont Agency of Transportation’s Town Highway Structures Grant Program administered by the District 6 office in Berlin. The town is initially required to pay for everything up-front and then the State reimburses the town for 90% of all the eligible costs, giving the town has a great opportunity to improve and update a piece of their infrastructure for about 10% of the overall cost.

For any municipality to be able to make such a substantial improvement to their infrastructure for an overall investment of just 10% is truly money well spent.